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HOW INSECTS AFFECT THE COTTON PLANT AND MEANS OF COMBATING THEM

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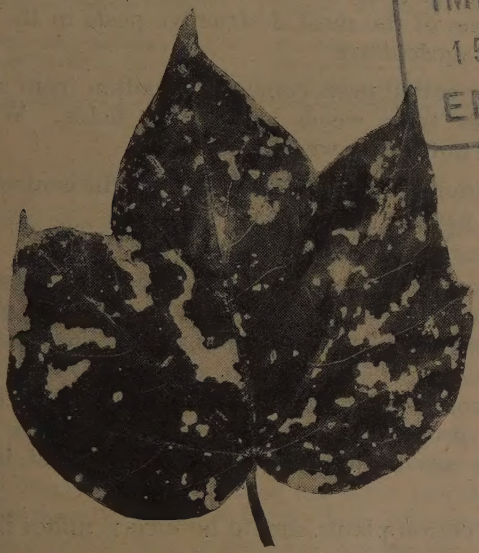

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UNITED STATES DEPARTMENT OF AGRICULTURE

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L. O. HOWARD, Chief

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THE COTTON PLANT is unusually attractive to insects and probably no other cultivated crop has as large a list of insect enemies. Among these are some of the most destructive pests in the history of agriculture.

Many cotton pests come to the cotton from other crops or from weeds around the fields. Weeds should not be allowed to grow.

Rotation of crops is of assistance in controlling cotton pests.

An early crop is necessary.

Poisons seldom are needed, except in poisoned baits in the spring and against red spiders, grasshoppers, and "worms" when they threaten the crop.

Thorough fall plowing, winter cover crops, early spring preparation, and repeated cultivation during the season are important measures of insect control.

The cotton plants should be turned under in the fall.

This bulletin describes the work of many insects and gives suggestions for their control.

A single system of control, effective against most of the insects referred to, is given in summary form on pages 26 and 27.

HOW INSECTS AFFECT THE COTTON PLANT AND MEANS OF COMBATING THEM.

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HOW COTTON ATTRACTS INSECTS.

NOT ONLY the squares and bolls of cotton, but the leaves and flowers are attacked by insects, and many species attack the stems and roots. In addition to the attraction of the plant to those insects which require it as food, the cotton plant is supplied with a peculiar means of attracting insects. On the underside of cotton leaves, on the midrib, or principal vein, and sometimes also on two other veins, one can find a little elongate depression which usually looks sticky and often holds a drop of liquid. On the outside of the squares at the base of each bract or leaflet are other little cups and between the bract and the bud itself are three more cups. At the bottom of the flower cup still others of these little vessels are found. They are called nectar cups, or nectaries, because they exude a sweet liquid. This liquid is greatly desired by many insects, beneficial and harmful, and is the means of attracting to the cotton plant a great variety of insect life.

As a result of the peculiar attractiveness of cotton for insects many specimens of harmless insects collected at the nectar are sent to entomologists under the impression that they are dangerous pests.

It would be impossible in a publication of this series to mention even briefly all of the cotton pests. The main object is to explain how insects affect the plant and to show how to distinguish the principal ones and how to combat them. The more important species, like the boll weevil and the bollworm, are treated fully in other publications.[1]

[1] See Farmers' Bulletin 848, "The Boll Weevil Problem with Special Reference to Means of Reducing Damage," and Farmers' Bulletin 872, "The Bollworm or Corn Earworm." These may be obtained free from the Division of Publications, U. S. Department of Agriculture.

Insect attack against cotton begins with the seedling and continues until the plant is destroyed when picking is over. It seems best, therefore, to discuss the pests from the standpoint of the season and the manner of attack.

HOW INSECTS MAY BE CONTROLLED BEFORE PLANTING.

The control of many insect pests should begin in the spring before they begin their attack. While they are still in the shelter of woods, buildings, weeds, etc., or dormant in the ground they are most vulnerable.

WEED DESTRUCTION.

Thorough destruction of weeds and cleaning up fence rows and brush will invariably assist in the reduction of insect damage. Such insects as tree crickets and some of the leafhoppers lay their eggs in weed stems. Destruction of the weeds naturally will destroy them. Weed destruction should not stop with the first cutting but should continue through the season. Further emphasis will be placed on this in another section of the bulletin.

WINTER PLOWING.

During the winter the soil is likely to conceal many potential enemies of the crops about to be planted. It is the habit of many species of insects to pass the winter months as larva ("worm" stage) or pupa (resting stage) in cells in the ground, where they are protected from the weather. A winter or very early spring plowing which disturbs them and exposes them to cold and rain is far more effective than any measure taken after they emerge and begin to reproduce. Winter plowing is an aid in the control of the bollworm, cutworms, grasshoppers, May beetles, and many other insects which injure cotton.

PESTS THAT MENACE THE STAND OF SEEDLING COTTON.

Many factors in cotton production have combined to make it necessary that the farmer push the growth of his cotton plantings as rapidly as possible. This is especially important in order that the greater part of the crop may be made before insect injury can reach its maximum. Of course this means that the planter must plant as early as it can be done with reasonable expectation of escaping a killing frost. Every farmer who has lived a number of years in a locality knows the usual time that the last frosts occur on his place and also knows which parts of a plantation are to be planted early and which later. He understands that some of his land is cold and slow to develop plant growth and that some of it is warmer and permits a more rapid growth. In case of doubt the

planter should ask advice from his State experiment station or the county demonstration agent.

In view of the necessity for an early crop, it is obvious that anything which retards the growth of the seedling cotton, or injures the stand so as to necessitate a replanting, is a serious drawback.

CUTWORMS.

The stand of cotton frequently is injured very seriously by cutworms (figs. 1, 2), of which there are numerous species. These "worms" are from one-half to an inch in length and of a dirty color.

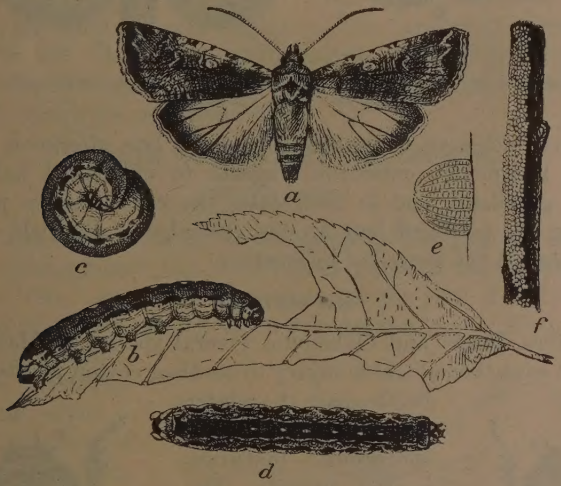

Fig. 1.—Varigated cutworm (*Peridroma margaritosa*): *a*, Moth; *b*, normal form of caterpiller, side view; *c*, same in curved position; *d*, dark form, view of back; *e*, greatly enlarged egg, seen from side; *f*, egg mass on twig. (Howard.)

They hide in the ground in the daytime and come out at night to do their work, which consists in cutting the stem in two or feeding on the leaves. The same kind of work is sometimes done early in the season by the nearly related southern grass worm,[1] but this species rarely attacks the plant until later.

The use of a poisoned bait is advisable if cutworms are numerous. This may be prepared as follows: Mix 50 pounds of wheat bran and 2 pounds of Paris green. Then bring the whole mixture to the consistency of a stiff dough by the addition of a low-grade molasses, such as is used in cattle rations, adding water when necessary. Distribute this bait over the infested field in small lumps. In case bran can not be obtained readily, middlings or alfalfa meal may be substituted. In fields known to be infested the distribution of this bait

[1] *Laphygma frugiperda* S. and A.

should be begun as soon as the cotton starts to appear above ground, so that the cutworms may be eliminated as quickly as possible and the skips replanted promptly. During the warmer spring months cutworms do most of their feeding at night and burrow into the soil to the depth of an inch or two during the day, so that the bait usually

FIG. 2.—A cutworm, *Agrotis ypsilon:* *a*, Larva; *b*, head of same; *c*, adult moth. Natural size. (Riley and Howard.)

will be more effective if applied during the late afternoon or early evening. Frequently cutworms migrate to cultivated fields from adjoining grassland, and in such cases the crops can be protected by placing the poisoned bait around the edge of the field or along the side nearest the source of infestation.[1]

MAY BEETLES.[2]

In western Texas and Oklahoma several species of May beetles (figs. 3, 4) cause considerable injury to seedling cotton plants. These beetles pass the winter in the grub stage in the ground, maturing in the spring. The wingless species are especially likely to injure the cotton if it is planted on newly broken fields or fields which were very grassy in the preceding year. These forms, being unable to fly, must attack the nearest vegetation. Some of the winged species also are reported as injurious to cotton. As has already been pointed out, winter plowing is of assistance in checking these beetles. The poisoned baits recommended for cutworms are of value against them.

FIG. 3.—May beetle, *Phyllophaga lanceolata*. Enlarged. (Sanderson.)

FIG. 4.—May beetle, *Phyllophaga cribrosa*. Enlarged. (Sanderson.)

[1] Extracted from Farmers' Bulletin 739. This bait is of value in the control of other pests and will be mentioned several times in this bulletin.

[2] (*Lachnosterna*) *Phyllophaga* spp.

OTHER PESTS THAT INJURE SEEDLINGS.

Many other pests from time to time seriously affect stands of seedling cotton in various parts of the country. Occasionally an early grasshopper outbreak occurs. In parts of Alabama and Mississippi cotton stands frequently are destroyed in a night by crayfish colonies. These creatures are not insects, but belong to the class of animals called Crustacea, which includes the crabs and lobsters. As they occur only where there is a considerable amount of water underground, their control is largely a matter of drainage. They live in colonies in a large chamber at the water level and reach the surface of the ground by long "chimneys." The placing of about an ounce of carbon disulphid in each "chimney," its opening thereupon being closed, will kill the inmate. Crustaceans of another group which injure cotton seedlings are the sowbugs and pill bugs.[1] They can be controlled readily by poisoned baits.

INJURIES WHICH ABORT THE GROWTH.

COTTON APHIS.[2]

One of the earliest insects to be found on the plant is the cotton aphis or "cotton louse" (fig. 5), which also attacks many other plants. The green "lice" are not conspicuous, but the rate of multiplication is so rapid that they can become a very serious pest. They suck the juices of the plant, sometimes causing death and often a curling or dwarfing of the leaf and malformation of the plant. They are seldom of enough importance to necessitate remedial measures, but when they attack small plots of cotton planted for purposes of selection, etc., it is advisable to spray with 40 per cent nicotine sulphate used at the rate of three-fourths of a pound to 100 gallons of water. Preventive measures, such as fall and winter plowing, to destroy them on their weed host plants, are much more effective than direct remedies.

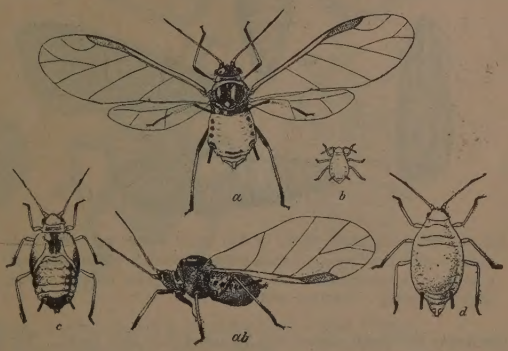

FIG. 5.—Cotton aphis: *a*, Winged female; *ab*, dark female, side view; *b*, young nymph, or larva; *c*, last stage of nymph; *d*, wingless female. All much enlarged. (Chittenden.)

[1] *Armadillidium vulgare* Latr., *Porcellio laevis* Latr., etc.

[2] *Aphis gossypii* Glov.

SOUTHERN GRASSWORM.[1]

The southern grassworm, or fall army worm (fig. 6), is not native to the United States, although occasionally it winters over in the extreme southern portions of the country. It feeds on many plants, grasses, and cultivated crops and is often a serious pest. Winter control is of no avail, as the attack follows the flight of the moths into new territory. The larvæ work very rapidly and cause considerable injury to the plants by gnawing the stem partly in two, eating the growing tips, and causing other injuries which result in a distorted growth and dwarfing of the plant.

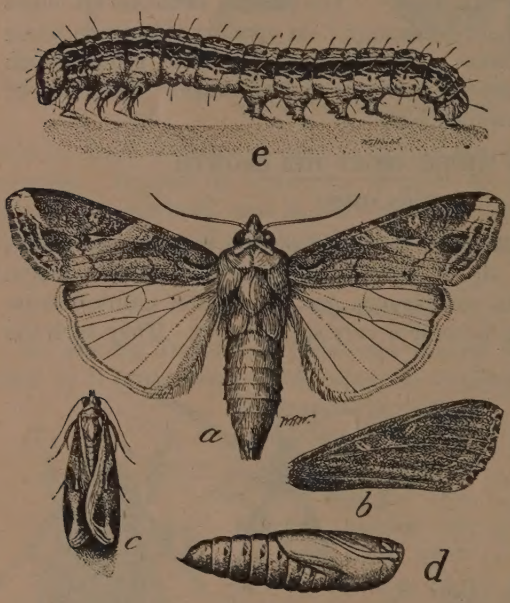

FIG. 6.—Southern grass worm, or fall army worm: *a*, Adult male moth; *b*, right front wing of female moth; *c*, moth in resting position; *d*, pupa; *e*, full-grown larva. *a*, *b*, *d*, *e*, about twice natural size; *c*, slightly enlarged. (Walton and Luginbill.)

When numerous on cotton, powdered arsenate of lead should be applied at the rate of about 5 pounds per acre. The usual method of utilizing cloth sacks on poles carried through the field on the back of a horse or mule is perfectly adapted to this crop. The following description of the construction and use of the outfit needed for this purpose is quoted from Farmers' Bulletin 872, "The Bollworm or Corn Earworm:"

A 4-inch board about 18 inches longer than the distance between the rows is used for the pole. To form the bags at either end, four blocks of the same material, each about 4 inches long, are nailed endwise to the underside of the pole. One of these is placed at each end and the other two about 16 inches from these to form the ends for the rectangular-shaped bags. An inch or one and a half inch hole is then bored through the pole about 8 inches from either end for pouring the poison into the bags. These holes are closed with corks when the outfit is in use. The sides of a rectangular piece of cloth are then tacked along each edge of the pole, and the ends to the side, and bottom of the blocks. If unadulterated Paris green is to be used, 8-ounce duck may be used for the bag, but lighter material is necessary for powdered arsenate of lead or Paris green mixed with flour. The poison sifts out over the plants as the pole is jarred by striking it with a

[1] *Laphygma frugiperda* S. and A.

stick as it is carried across the back of a mule ridden between the cotton rows. Two rows are thus treated at once and from 15 to 20 acres can be covered by one man during the early morning and evening hours which are suitable for the work. It is best to apply the poison when the plants are moist with dew so that it will adhere to the foliage. It is also necessary to avoid windy periods.

If the worms are in grass plots or cultivated fields adjoining cotton, the poisoned bait described for cutworms will be effective in keeping them from the cotton. In some cases where the ground is hard, with little vegetation, the use of heavy rollers or brush will be of advantage in crushing the worms. Deep furrows around the field will catch many worms moving into a field and in these they may be crushed.

When they are full grown they enter the soil and change to pupæ. A shallow cultivation by disking or with a spring-tooth harrow at this time is very effective, as it will kill many pupæ and expose others to the heat of the sun.

INJURIES TO THE GROWING TIP.

The growing tip of cotton frequently is injured by insects which make their principal attack on other parts. The boll weevils in the spring frequently injure the terminal bud when they emerge from hibernation before the squares form. Grassworms, cutworms, and grasshoppers do similar injury. Frequently small "worms" which make a web around the leaf or bud are to be found. These belong to

Fig. 7.—Cowpea-pod weevil: *a*, Adult weevil; *b*, larva, side view; *c*, head of same, front view; *d*, pupa, viewed from below. Much enlarged. (Chittenden.)

several different genera[1] of moths and are not often of grave importance. As they are usually insects which normally attack some weed, another argument for weed control and fall plowing is afforded.

The cowpea-pod weevil[2] (fig. 7) frequently attacks young cotton and causes injury by puncturing the terminal bud. These attacks usually occur when cotton follows cowpeas.

[1] Platynota, Loxostege, etc.

[2] *Chalcodermus aeneus* Boh.

LEAF INJURIES AND DEFOLIATION.

Cotton leaves are attacked by many insects, some of which are usually considered of little importance, although in small areas they frequently do serious injury. Dusting with arsenate of lead is probably the best general remedy for cotton defoliators, such as beetles, "worms," and grasshoppers. This may be done by the pole-and-bag method or by the use of a dust gun with a rotary fan.

COTTON LEAFWORM.[1]

The best known defoliator of cotton is the cotton leafworm (fig. 8), sometimes called the cotton army worm. It is not present in the country every year. It is a native of tropical regions, but from time to time it flies to this country and often by the end of the season has stripped the cotton fields of foliage. The moths are tawny, with a wing expanse of slightly more than an inch. They lay small green eggs singly on the leaves of cotton. The larvæ are elongate, somewhat variable in coloring, some being yellowish green without prominent stripes, while others have a black stripe down the back with a fine central yellow stripe. Each segment has four black dots above. The larva when full grown webs one or two leaves together to form a cocoon and pupates therein, hanging the pupa by a thread to the stem. As the worms do not attack other plants and do not enter the ground, cultivation and weed control are of no avail against this species. When the attack is late in the season the defoliation is often beneficial, as it hastens the ripening of the fruit and cuts off the food supply of the boll weevil. But often the worms appear so early as to be capable of inflicting serious damage, especially to late crops. In such cases it is advisable to dust with arsenate of lead at the rate of about 4 pounds to the acre, more or less, depending on the size of the cotton. It is best to apply the poison when the leaves are moist with dew and when the winds are low. The planter should not wait until the defoliation is heavy.

GRASSHOPPERS.

Frequently the cotton fields of Texas and sometimes of the other cotton States are seriously injured by grasshoppers, among which the differential grasshopper[2] (figs. 9, 10) and the Southwestern lubber grasshopper[3] (fig. 11) are the most injurious.

These insects lay their eggs in masses in the ground and therefore are subject to control by cultivation where that is possible. The grasshoppers usually advance on cotton fields from near-by waste places. Where young grasshoppers appear in great numbers they may be controlled by spraying with kerosene or crude oil, trapped by the poisoned bait mentioned for cutworms, or crushed by drags or

[1] *Alabama argillacea* Hübn. [2] *Melanoplus differentialis* Thos. [3] *Brachystola magna* Gir.

FIG. 8.—Cotton leafworm: Stages and work.

rollers. When the lubber grasshoppers appear, control measures must be taken immediately, because these insects can destroy a plant very quickly.

COTTON RED SPIDER.[1]

One of the most destructive enemies of cotton is the red spider (figs. 12–15), which is not an insect, but a mite. These mites can hardly be seen on the cotton leaf, except by a trained eye or with the aid of a magnifier, unless very numerous, when their minute moving red bodies make them distinguishable. They multiply so rapidly that they may spread from a single infested weed over an entire cotton field during the season. They suck the juices and cause the leaf to turn red and finally kill the plant. They usually work on the underside of the leaf.

FIG. 9.—Differential grasshopper: Above, adult male; below, adult female. Twice natural size. (Walton.)

As the red spider is dependent on other plants to carry it through the winter, it is apparent that weed control is a very important element in reducing damage by this pest. Special bulletins are available for those desiring complete information.[2]

The destruction of weeds, especially the pokeweed, and of cultivated plants such as the violet, from which the mites make their way to the cotton, and the destruction by plowing up and burning of early infested cotton plants are effective measures, which should be used as primary means of control.

FIG. 10.—Egg mass of differential grasshopper. Enlarged. (Sanderson.)

When a cotton field is threatened by the red spider it is often advisable to spray. The following sprays are effective: (1) Potassium sulphid (1 ounce to 2 gallons of water); (2) lime-sulphur solution

[1] *Tetranychus telarius* L.

[2] Department Bulletin 416, "The Red Spider on Cotton," and Farmers' Bulletin 831, "The Red Spider on Cotton and How to Control it."

(homemade or commercial); (3) kerosene emulsion[1]; (4) flour-paste solution (1 gallon stock paste to 12 gallons water).

LEAF-CUTTING ANT.[2]

The so-called leaf-cutting or parasol ant is well known in southwestern Texas, where it is often destructive to cultivated crops, including cotton. The ants cut the leaves from a plant and carry them to the nest The leaves are finely divided and made into small pellets, by means of the mandibles and legs. The pellets are placed upon the so-called fungus garden, where they furnish a growing medium for the fungus on which the colony feeds.

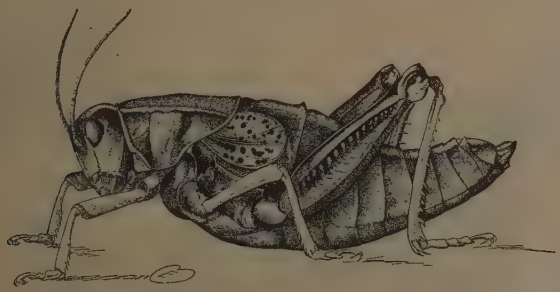

FIG. 11.—Southwestern lubber grasshopper; Adult female, natural size. (Walton.)

FIG. 12.—The female red spider. Highly magnified. (McGregor and McDonough.)

The best method of control is by means of potassium or sodium cyanid, a deadly poison. The cyanid is used at the rate of 1 ounce to 1 quart of water. After careful mixing the liquid is poured into each opening of the nest, a quart to an opening. Two applications may be necessary to exterminate the colony. *Care must be taken not to breathe*

FIG. 13.—Cotton plantin well advanced stage of infestation by the red spider. Nearly all leaves, squares, and bolls have been shed. (McGregor,)

[1] Kerosene emulsion is made by combining 1 gallon of kerosene and one-fourth pound of laundry soap, or 1 pound of whale-oil (fish-oil) or other soap, or 1 pint of soft soap, with half a gallon of water. The laundry soap, if dry, is shaved and dissolved in boiling water and then poured (away from the fire) while still boiling hot into the kerosene. The mixture is then churned rapidly 8 or 10 minutes, the liquid being pumped back upon itself by means of a sprayer with a nozzle throwing a strong, solid stream. At the end of this time the mixture becomes a thick cream—the stock emulsion. In the preparation of the emulsion a sprayer is necessary. For most species of sucking insects 1 part of the stock emulsion should be mixed with 15 parts of water.

[2] *Atta texana* Buckley.

the deadly fumes of this poison. Gloves should be used in handling this poison to prevent any of it from coming in contact with abrasions of the skin. The action of the poison on the blood is more deadly than the fumes which might be breathed in the handling, when done out of doors. All refuse should be buried immediately, and the hands washed carefully.

FIG. 14.—A severe example of red-spider work in a cotton field. Nearly all plants in the foreground are in the condition shown in figure 13. The source of infestation was certain pokeweed stalks growing in the weed border seen in the upper right-hand corner of the picture. (McGregor.)

FIG. 15.—Ideal spraying outfit for treatment of considrable red-spider infestation. (McGregor.)

SALT-MARSH CATERPILLAR.[1]

The salt-marsh caterpillar (fig. 16) is one of the species of "woolly-bears," several of which may at times seriously injure cotton. This species is almost always to be found in the fields. The eggs are laid in masses. The larvæ are covered with long hairs and are somewhat variable in color. They feed on many kinds of foliage and usually come to the cotton fields from some adjoining weedy area. The

FIG. 16.—Salt-marsh caterpillar: *a*, Female moth; *b*, half-grown larva, or caterpillar; *c*, full-grown larva, side view; *d*, head of larva, front view; *e*, egg mass. All slightly enlarged, except *d*, which is more enlarged. (Chittenden.)

larvæ when full grown spin a silken cocoon surrounded by rubbish, on the ground or among the leaves of the plant.

Control of the weeds around the field is naturally the best way of preventing damage by this species and its allies.

OTHER LEAF EATERS.

Many other kinds of caterpillars occasionally injure cotton, such as that of the large tiger moth,[2] the beet army worm,[3] the fall web-worm,[4] and that of the io moth.[5] The larvæ of the io moth are green and covered with poisonous spines. They are very pretty and also well known, to all who have ever touched them, as "stinging caterpillars." They cause a very painful rash when touched. If abundant enough to warrant it, all of these insects can be controlled by dusting

[1] *Estigmene acraea* Dru.
[2] *Apantesis arge* Dru.
[3] *Caradrina exigua* Hübn.
[4] *Hyphantria cunea* Dru.
[5] *Hyperchiria io* Fab.

the plants with arsenate of lead, but they will not be serious if proper attention is given to surrounding vegetation on which they feed normally.

HOW INSECTS REDUCE THE YIELD.

Naturally the most serious injury to the cotton crop is that which affects the squares, flowers, and bolls, and among the insects causing this injury are some of the most serious known insect pests.

COTTON-BOLL WEEVIL.[1]

The worst cotton pest in this country, and probably the most destructive cotton insect in the world, is the Mexican cotton-boll weevil (figs. 17, 18), which annually takes a toll of tens of millions of dollars from the cotton industry. As this insect is of such great importance, many bulletins have been written about it, and the most recent of these may be obtained on application to the Division of Publications, United States Department of Agriculture, Washington, D. C. The boll weevil lays its eggs in the squares and bolls. Generally the squares which have been attacked will fall to the ground in a few days. They always flare and often hang and dry on the plant. The eggs hatch into small white grubs, or larvæ, with yellowish-brown heads. These feed in the square or boll and grow until they are half an inch long. They usually are curved and are legless. When full grown the grub forms a hard cell and turns into a pupa, which matures in about three days into the adult weevil.

FIG. 17.—Adult female boll weevil with wings spread. Much enlarged. (Hunter and Pierce.)

The weevil is easily detected in a field. If a square is found with its bracts flared and showing a little wartlike puncture, it can be put into a tumbler and covered with cheesecloth. After 2 or 3 days the white larva can be easily found, and in about 10 or 12 days the full-grown weevil will come out.

The control of the weevil is brought about by early planting, selection of the best local varieties, intensive cultivation, early picking of the crop, and destruction of the cotton plants, or at least destruction of the green growth, before frost. All of these methods will also help in controlling the other cotton pests.

[1] *Anthonomus grandis* Boh.

FIG. 18.—Cotton plant attacked by boll weevil: *a*, Hanging dry square infested by weevil; *b*, flared square, with weevil punctures; *c*, cotton boll, sectioned, showing attacking weevil and weevil larva in its cell. (Hunter and Pierce.)

BOLLWORM.[1]

The well-known bollworm (figs. 19, 20) is called the corn earworm when it attacks the ears of corn. It is likewise a pest of tomatoes, tobacco, beans, and alfalfa. The eggs are laid singly. The larvæ bore into the squares and bolls and eat out the interior, usually leaving by another hole and going to another square or boll.

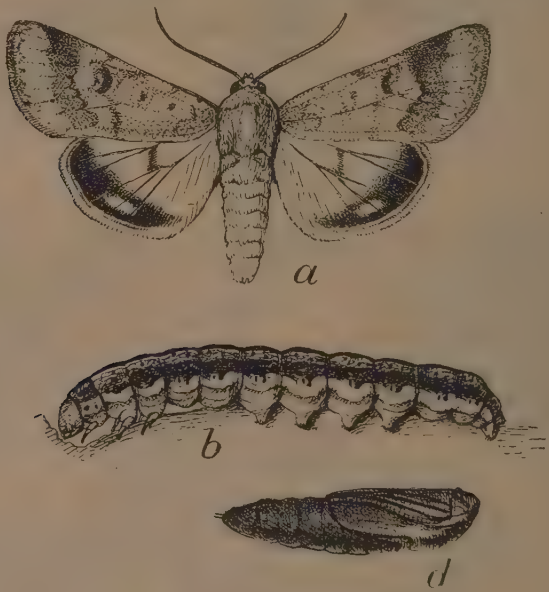

FIG. 19.—Bollworm: *a*, Moth, or adult; *b*, larva, or worm; *d*, pupa. About natural size. (Howard.)

Thus a single worm during its development may injure all the forms on several branches. When full grown, it enters the ground for pupation, emerging in about two weeks as a moth. The bollworms pass the winter as pupæ in the soil.

Thorough plowing of the land during the fall and winter and frequent cultivation of the growing crop will destroy many bollworm pupæ and expose others to the action of rain and frost, sunshine, and insect enemies, and to insect-eating birds and rodents. In combatting the bollworm as well as the weevil an early crop is necessary. If its attack is very serious, poisoning with powdered arsenate of lead by the pole-and-bag method, described under "Southern grass worm," p. 8, is to be recommended.

[1] (*Heliothis*) *Chloridea obsoleta* Hübn.

COTTON SQUARE-BORER.[2]

Frequently the squares are bored by small, oval, flattened, pea-green, velvety-haired larvæ, known as square-borers (fig. 21). Each larva can destroy many squares. The larvæ transform into small pupæ, and when mature these become the dainty little blue swallow-

FIG. 20.—Vertical section through the soil, showing pupa of bollworm in its burrow. (Bishopp and Jones.)

tailed butterflies so often seen in the cotton fields. It is seldom necessary to take active measures against them, but when advisable powdered arsenate of lead is recommended.

COTTON-BOLL CUTWORM.[2]

The cotton-boll cutworm (figs. 22, 23) looks like an ordinary cutworm but it feeds by day on the foliage and bores into squares and bolls. The larvæ are olive or greenish brown and easily recognized by the

[1] *Uranotes melinus* Hübn. [2] *Prodenia ornithogalli* Guén.

two rows of triangular velvety-black spots extending down the back. Four or five broods a year occur in Texas. By picking them off of young cotton when chopping in the spring they may be largely controlled. As they pupate in the soil, frequent cultivations destroy the pupæ.

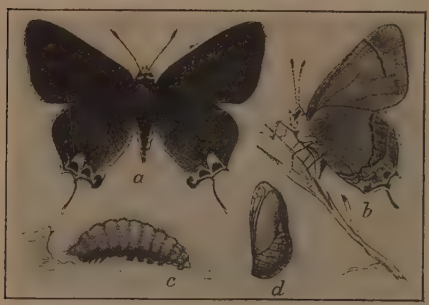

FIG. 21.—Cotton square-borer: *a*, Adult butterfly, top view; *b*, same from side, with wings closed; *c*, larva, or borer, from side; *d*, pupa; *e*, egg. *a–d*, Somewhat enlarged; *e*, greatly enlarged. (Howard.)

COTTON STAINER.[1]

The cotton stainer (fig. 24) is important only in the Southeast, especially in Florida. It is a sucking bug with a long beak. The body is red, with dark-brown or black wings. It feeds on the juices of many plants. The young are similar to the adult except that the wings are not developed. Much injury is done to cotton by the staining of the fiber. In sections where this bug is abundant, measures should be taken to hold down the growth of weeds, upon which the stainer breeds in great numbers. Principal among these weeds are Spanish cocklebur[2] and nightshade.[3] They may be trapped by placing small bunches of cotton seed in different parts of the field.

FIG. 22.—Cotton-boll cutworm: Above, dark form of moth, male; below, pale form of moth, female. Somewhat enlarged. (Chittenden.)

FIG. 23.—Cotton-boll cutworm: *a*, Light form of larva; *b*, dark form of larva. Somewhat enlarged. (Chittenden.)

As soon as the young bugs make their appearance in the spring, the colonies should be sprayed with kerosene emulsion, or jarred into buckets of water having a film of kerosene.

[1] *Dysdercus suturellus* H. Schf. [2] *Urena lobata*. [3] *Solanum nigrum*.

COTTON BUGS.

Many different species of sucking bugs [1] attack the cotton squares and bolls and do serious injury. Many of them are known as

FIG. 24.—Cotton stainer: *a*, Fourth-stage nymph, or pupa: *b*, adult. Enlarged. (Insect Life.)

"pumpkin bugs" and "stinkbugs," but most of them are simply called plant-bugs.

Usually they breed on many plants besides cotton and are kept under control best by preventing excessive weed growth around cotton fields. It has been proved that some of these bugs carry plant diseases of cotton, and hence they are to be regarded as serious pests. Several species are illustrated (see figs. 25–29).

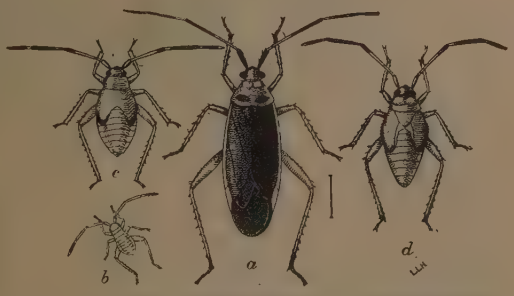

FIG. 25.—Cotton leaf-bug, *Adelphocoris rapidus: a*, Mature bug; *b*, young nymph; *c*, fourth stage of nymph; *d*, fifth stage of nymph. Much enlarged. (Sanderson.)

FLOWER BEETLES.

Frequently beetles are found in the blooms of cotton, and occasionally they are numerous enough to do much damage. The blister beetles [2] (see fig. 30) and soldier beetles [3]

[1] *Adelphocoris rapidus* Say, *Leptoglossus phyllopus* L., *Largus succinctus* L., *Nezara hilaris* Say, *Jadera haematoloma* H.-Schf., etc.

[2] *Epicauta vittata* Fab., *E. lemniscata* Fab., *E. cinerea* Forst., *E. ferruginea* Say, etc.

[3] *Chauliognathus* spp.

feed on the petals and eat the pistil and stamens. In case of injury to the pistil the boll frequently fails to mature. These insects in their immature stages prey on other insects and are beneficial.

LEAF BEETLES.

A number of small leaf beetles—some brown, some blue, some green, or striped with yellow—occur on cotton squares and feed on the bracts or sometimes eat the leaves of cotton. They are native to weeds around the fields, and are seldom important.

FIG. 26.—Cotton boll showing punctures of a cotton leaf-bug, *Adelphocoris rapidus*. (Sanderson.)

INJURIES TO THE STALK AND ROOTS.

COTTON WIREWORMS.

In South Carolina much injury is done to the roots of cotton by wireworms[1] (see fig. 31). The adults of these worms are the well known click-beetles so abundant at the flowers and squares of cotton. They are controlled best by using a crop rotation in which cotton follows oats and corn follows cotton. The oats stubble should remain on the land until September 15. After this time it is well to prepare the land and plant a winter cover crop. The cover crop should be supplemented with stable manure, swamp muck, or lime, as it is necessary to build up soil infested by wireworms.

CORN ROOT-APHIS ON COTTON.[2]

Especially in South Carolina the cotton is attacked at the roots by the root-aphis of corn. This insect is similar in appearance to the cotton aphis but confines its attacks to the taproot of cotton. The best control is a three-year system of rotation in which cotton does not follow either corn or cotton. Small grain or cowpeas should precede cotton on badly infested lands. The three-year rotation of oats and cowpeas, cotton, and corn has proved successful. It is of great value to have a winter cover crop on infested lands at all times, as it prevents the winter food plants of the cotton root-aphis from growing upon the land.

FIG. 27.—Leaf-footed plant-bug (*Leptoglossus phyllopus*) twice natural size. (Hubbard.)

[1] *Monocrepidius vespertinus* Fabricius, *Horistonotus uhleri*[3] Horn, and related species. For an account of these and other species see Farmers' Bulletins 725 and 733

[2] *Aphis maidiradicis* Forbes.

MOTH STALK-BORER.[1]

Occasionally cotton stalks are bored by the caterpillar of the stalk-borer (fig 32). Ordinarily it attacks various weeds, including "bloodweed."[2] Weed destruction, therefore, is the obvious control measure.

FIG. 28.—A plant-bug, *Leptoglossus oppositus*. Twice natural size. (Chittenden.)

COTTON STALK-BORER BEETLE.[3]

The cotton stalk-borer beetle sometimes is found in Texas boring in cotton stalks, but it is supposed to attack only plants damaged by some other agency.

SNOWY TREE CRICKET.[4]

In the fall of the year cotton stalks frequently are found with the stems roughened by the egg punctures of the snowy and other tree crickets. These tree crickets also oviposit in weeds. They pass the winter in the egg stage in the old stalks and in the spring the young crickets hatch. They feed on vegetation of all kinds. Fall destruction of cotton stalks and weeds is a practical control measure.

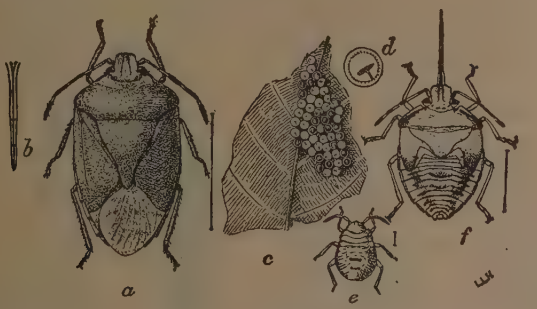

FIG. 29.—The green soldier bug (*Nezara hilaris*): *a*, Mature bug; *b*, beak of same; *c*, egg mass; *d*, single egg; *e*, young nymph; *f*, last stage of nymph. All enlarged; *b*, *d*, more enlarged. (Sanderson.)

SHARPSHOOTERS.[5]

The leafhoppers seen so frequently on the cotton stalks (see figs. 33–36) in the late summer and fall, dodging out of sight around the stem, are commonly called "sharpshooters" with the doubtful

[1] *Papaipema nitela* Guén.
[2] *Ambrosia trifida* and other species of Ambrosia.
[3] *Ataxia crypta* Say.
[4] *Oecanthus niveus* DeG.
[5] *Homalodisca triquetra* Fab., *Oncometopia undata* Fab., *Oncometopia lateralis* Fab., and *Aulacizes irrorata* Fab.

assumption that they puncture the squares and bolls. They do puncture the stalks and lay their eggs in the leaves just under the surface, forming a blisterlike mark.

INSECTS IN DECAYED AND DRY BOLLS.

Cotton bolls which have become affected by anthracnose and other diseases furnish an attraction to many bugs and beetles, which no doubt often are instrumental in spreading the infection. Very few of these insects found feeding in the rotten spots have any primary importance to the cotton plant. Dry bolls which have matted fiber are often filled with small beetles, little white "worms," and larger pink "worms." These are all feeders on decayed matter. (The pink "worms" are not to be confused with the pink bollworm[1] of cotton which ultimately may become a pest in this country, the larvæ of which will be found in the winter in bolls with healthy fiber, in seeds, or in cells formed by uniting two seeds.) Boll-weevil larvæ, pupæ, and adults frequently may be found in cells in old bolls, which in addition may serve as shelter for other pests. As some of the insects which are merely scavengers in cotton bolls are recorded as injurious on other plants, it is important that all cotton plants be disposed of as soon after the cotton is picked as is practicable.

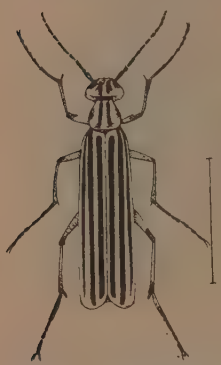

FIG. 30.—A blister beetle, *Epicauta lemniscata*. Enlarged. (Chittenden.)

THE DOUBLE RÔLE OF ANTS.

Of course every cotton field has its ant colonies. When the ants are large species, such as the leaf-cutting ant[2] or the Texas agricultural ant,[3] the colonies should be destroyed as described under the paragraph on the former (p. 13). The smaller ants which swarm over the cotton plants are very helpful in ridding the plant of many enemies,

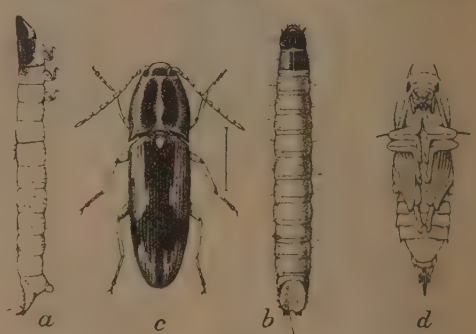

FIG. 31.—A cotton wireworm, *Monocrepidius vespertinus*: *a*, Larva, or wireworm, side view; *b*, same, top view; *c*, adult, or beetle; *d*, pupa. Much enlarged. (Chittenden.)

[1] *Pectinophora gossypiella* Saunders.
[2] *Atta texana* Buckley.
[3] *Pogonomyrmex barbatus molefaciens* Buckley.

for they attack in numbers insects much larger than themselves. Several species of ants[1] are very efficient enemies of the boll weevil.

FIG. 32.—Moth stalk-borer: *a*, Female moth; *b*, half-grown larva, or borer; *c*, full-grown larva in injured stalk; *d*, side view of segment of abdomen of same; *e*, pupa. All somewhat enlarged. (Chittenden.)

They eat their way into fallen infested squares and devour the weevil larvæ, pupæ, and adults. In this way they often add 10 to 20 per cent to the natural control of the weevil. But these same ants are fond of sweets and they foster the honeydew-secreting aphids, white flies, and scales, which are found on cotton, transplanting them to new colonies. They are diligent in protecting the aphids, or "lice," from voracious enemies and in this way become enemies of the cotton planter. On the whole, however, it is believed that the smaller ants do at least as much good as harm and should be let alone.

FIG. 33.—A "sharpshooter," *Oncometopia undata:* Adult at left, nymph, or young, at right. Greatly enlarged. (Sanderson.)

THE PARASITES.

Practically all of the pests mentioned on other pages are held more or less in control by other insects which prey on them or live at their

[1] Especially species of Solenopsis, Pheidole, Monomorium, and Iridomyrmex.

expense. The little parasites are so inconspicuous that they seldom are seen, but often their work is very effective. All the measures which are recommended for the control of the various pests, except the use of poisons, will serve to favor parasite attack, which will go on without other effort by the planter.

INSECT VISITORS OF COTTON.

Many of the wasps and bees that visit cotton are there only for nectar or pollen and incidentally they serve to fertilize the plants. It is thus that most of our plants are fertilized. The nectar attracts

FIG. 34.—A "sharpshooter," *Oncometopia lateralis:* Adult at left; nymph, or young, at right. Greatly enlarged. (Sanderson.)

FIG. 35.—A "sharpshooter," *Aulacizes irrorata:* Adult. Greatly enlarged. (Sanderson.)

multitudes of insects which have nothing to do with cotton otherwise. When weeds are allowed to grow and nourish pests and are suddenly cut or destroyed, one may expect a large increase of insects on cotton, many of which will be injurious. *The weeds must not be allowed to grow.*

SUMMARY OF CONTROL MEASURES.

In summary of the preceding paragraphs a single system may be devised for cotton-insect control.

BEST MEASURES FOR THE EARLY SPRING.

1. Keep down weed growth around the farm.
2. Plow in the winter to break up the winter cells in the ground.
3. When necessary set out poisoned baits to trap cutworms, grasshoppers, May beetles, etc.
4. Plant as early as it can be done safely and yet avoid killing frosts. Plant the variety which is found to be the best producer in your own locality, and which has the qualities of rapid and prolific fruiting.
5. Space the rows in accordance with local experience
6. Cultivate frequently, but not deeply.

BEST MEASURES TO FOLLOW DURING THE SUMMER.

1. Continue cultivation until the crop is made, or as long as possible.
2. Watch for the first appearance of worms.
3. Dust the cotton with powdered arsenate of lead as soon as grasshoppers or "worms" begin to attack, unless "worm" attack starts late and would hasten ripening.
4. Keep down the weeds.

WHAT TO DO IN THE FALL.

1. Pick the cotton out as soon as possible.
2. Destroy the plants by plowing under or grazing as long before frost as possible.
3. Where practicable plow the fields and plant a cover crop.
4. Where feasible follow a three-year rotation with cotton following some crop other than corn.

FIG. 36.—A "sharpshooter," *Homalodisca triquetra:* Adult at left; last-stage nymph, or young, at right, above; young nymph at right below. Greatly enlarged. (Sanderson.)

PRACTICAL MEASURES FOR THE WINTER.

1. Clean up all turn rows and fence rows.
2. Cut and burn all weeds.
3. Plow under all stubble fields that are not to be used otherwise.
4. Grub up old stumps.

PUBLICATIONS OF U. S. DEPARTMENT OF AGRICULTURE RELATING TO INSECTS INJURIOUS TO COTTON OTHER THAN THE BOLL WEEVIL.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Fall Army Worm, or "Grass Worm," and its Control. (Farmers' Bulletin 752.)
Red Spider on Cotton and How to Control it. (Farmers' Bulletin 831.)
Carbon Disulphid as an Insecticide. (Farmers' Bulletin 799.)
Bollworm or Corn Earworm. (Farmers' Bulletin 872.)
The Argentine Ant: Distribution and Control in the United States. (Department Bulletin 377.)
The Red Spider on Cotton. (Department Bulletin 416.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Miscellaneous Cotton Insects in Texas. (Farmers' Bulletin 223.) Price, 5 cents.
Two Destructive Texas Ants. (Entomology Circular 148.) 1912. Price, 5 cents.
Cotton Stainer. (Entomology Circular 149.) 1912. Price, 5 cents.
Cotton Worm or Cotton Caterpillar. (Entomology Circular 153.) 1912. Price, 5 cents.
Report on Miscellaneous Cotton Insects in Texas. (Entomology Bulletin 57.) 1906. Price, 5 cents.
Cotton Stalk-borer. (Entomology Bulletin 63, pt. VII.) 1907. Price, 5 cents.
Mexican Conchuela in Western Texas in 1905. (Entomology Bulletin 64, pt. I.) 1907. Price, 5 cents.
Notes on Economic Importance of Sowbugs. (Entomology Bulletin 64, pt. II.) 1907. Price, 5 cents.
Plant-bugs Injurious to Cotton Bolls. (Entomology Bulletin 86.) 1910. Price, 20 cents.
Argentine Ant. (Entomology Bulletin 122.) 1913. Price, 25 cents.

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